Vol. IX, Nos. 3-4 September—December, 1957

DIRECTORATE OF PLANT PROTECTION, QUARANTINE AND STORAGE
MINISTRY OF FOOD AND AGRICULTURE, GOVERNMENT OF INDIA

PLANT PROTECTION BULLETIN

SCIENCE IN PRACTICE

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Issued by the
PLANT PROTECTION ADVISER TO THE GOVERNMENT OF INDIA,
NEW DELHI.

Published Quarterly

		Inland	Foreign
SUBSCRIPTION RATES	Single Copy	Re. 1·50 nP.	2*sh.* 3*d.*
	Annual	Rs. 3·00	5*sh.*

Available from:

THE MANAGER OF PUBLICATIONS, CIVIL LINES, DELHI-8.

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NOTE

This Bulletin is intended to disseminate information about plant protection measures and campaigns, adopted or conducted in different parts of India, as well as about the advances made in the field of plant protection in other parts of the world to the extent possible. It is also intended to give information about the latest developments in the production and use of pesticides and plant protection equipment as well as about techniques of pest and plant disease control. Elaborate scientific papers on Entomology or Plant Pathology or on the chemistry of pesticides would normally not be in place in this Bulletin but short notes dealing with the behaviour or distribution of pests and plant diseases and brief reports on their epidemiology, control, etc., would be welcome. Plant protection has now become such a specialised science and yet is so diversified and consequential in its character and application that it is difficult to define the scope of the subject with any great precision. The general rule to be observed is that any information which can be useful in preventing or controlling damage to crops, fruit trees, plantations and stored agricultural commodities, caused by pests and diseases, should be a fit subject for publication in this Bulletin.

Manuscripts submitted for publication in the Plant Protection Bulletin must be typed in double spacing on one side of the paper only, leaving ample margin on the left, at the bottom and on the top of the page. Photographs or drawings must be accompanied by a clearly typed legend for being reproduced under them. In addition, they should bear, on the reverse, in clear handwriting in pencil, the name or names of the author or authors and the article which they illustrate. Local names of insects, diseases, weeds, crops and plants, if used, must be commenced with a small, not capital, letter and underlined and must invariably be followed by their scientific or well known English names. Localities or place names should be clearly indicated by reference to well known districts or States or both.

While this Directorate will take every care to include only such material in the Bulletin as may be considered reasonably correct and useful, it can accept no responsibility for every statement made and every opinion expressed. Due to various unavoidable reasons, the appearance of this Bulletin has been far behind the scheduled time. While this must be greatly regretted, every effort would be made to avoid delays in future. Those who may read this Bulletin are invited to offer criticisms and suggestions for its improvement.

New Delhi

K. B. LAL,
PLANT PROTECTION ADVISER TO THE
GOVERNMENT OF INDIA

METHYL BROMIDE FUMIGATION

BY

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A large volume of literature has accumulated in recent years on the use of methyl bromide as a fumigant. Methyl bromide has been widely and effectively used in many parts of the world in warehouses, mills, granaries, green-or glass-houses and in plant quarantine work for the disinfestation of plant materials and products. Much of the literature is, however, scattered and spread over in many publications. In the following pages, an attempt has been made to collect information from different sources and to present it in a form convenient and helpful to the user. Brief notes on the properties, uses, precautions necessary in handling, and dosage schedules for various plant materials are given.

Methyl bromide is effective against most insects in any stage of development, as well as against red spiders and other mites. In recent years it has been widely used for the control of pests of cereal products, stored cereals, dried fruits, stored food stuffs, fresh fruits, vegetables, nuts, dairy products, dried roots, spices, herbs, dormant and growing plants, seeds, tobacco, clothes, furnishings, furniture, fabrics, fibres, packing and wooden structures. It has unusual properties of penetration which make possible the destruction of sheltered pests such as stored product pests, mites, leaf miners, borers and other internal feeders. It kills rats and mice at dosages below those normally used for insect fumigation. Many kinds of seeds can be fumigated without affecting their germination capacity. Methyl bromide is effective over a wide range of temperatures.

Physical and Chemical Properties

Boiling point	3·6 °C (38·5 °F)
Molecular weight	94·94
Specific gravity (at 0 °C)	1·732
Volume per lb. (at 0 °C)	262 ml.
Vapour density (at 20 °C; air=1)	3·27
Specific heat of liquid at 0 °C	0·12 cal./g/ °C
Latent heat of vaporization at 10 °C	61·8 cal./g

Vapour pressure

Degrees C.	Degrees F.	Absolute Pressure Lb. per sq. in.	Approx. gauge reading Lb. per sq. in.
0	32	12	—
4	39	15	0
10	50	17·5	2·5
20	68	25·5	10·5
30	86	35·5	20·5
40	104	48·5	33·5
50	122	65	50

The following are some useful conversion factors for concentrations of methyl bromide in air at 20° C and 76 cm. pressure :

1 mg. per litre..	=1 oz. per 1,000 cu. ft. =0·0253% by volume =253 parts per million (p.p.m.)
1% by volume	=39·5 mg. per litre
17 parts per million	=0·067 mg. per litre

Methyl bromide (CH_3Br) is a colourless, odourless, volatile liquid. It is a gas under ordinary temperatures and is approximately 3.3 times as heavy as air. For the purposes of fumigation, methyl bromide can be considered as non-inflammable. It is widely used as a fire extinguisher.

It has no corrosive action on most metals, but aluminium fittings should be avoided. Methyl bromide affects many plastics and organic materials. Natural rubber is strongly attacked but the dilute concentrations of vapour in air used in fumigation have little effect. Therefore, it is possible to use sheetings coated with synthetic rubber and plastics. Polyethylene appears to be least affected.

Methyl bromide is only very slowly soluble in water. The gas readily diffuses laterally and downwards but very slowly upwards. However, circulation overcomes this difficulty and permits good distribution. Circulation also hastens penetration and lessens leakage.

Calculation of Dosage

The dosage is calculated either (1) by weight or (2) by measurement.

(1) When a dose of methyl bromide is calculated by weight, the following formula is used.

Divide the volume of the chamber by 1,000 cu. ft. and then multiply this quotient by dosage rate as expressed in pounds per 1,000 cu. ft., *e.g.*, for a dose of 2 pounds per 1,000 cu. ft. in a 1,500 cu. ft. chamber, it would take $\frac{1,500 \times 2}{1,000} = 3$ lb.

(2) When a dose of methyl bromide is to be measured by volume, the following formula is used.

Multiply the index of the desired rate by the capacity of the chamber in cubic feet. Since one pound of methyl bromide = 262 cc., a dosage of one pound per 1,000 cu. ft. would be 262 cc. of methyl bromide per 1,000 cu. ft. or 0.26 cc. per cu. ft. Thus 0.26 cc. per cu. ft. is the index for one pound per 1,000 cu. ft. For example, to calculate the quantity of methyl bromide required for a 30 cu. ft. chamber at the rate of one pound per 1,000 cu. ft., multiply 0.26 by 30. This comes to 7.8 cc., which would be the required quantity of methyl bromide. Indices for other dosages are given below :—

Rate	Index
1·5 lb. per 1000 cu. ft.	0·39 cc. per cu. ft.
2·0 lb. per 1000 cu. ft.	0·52 cc. per cu. ft.
2·5 lb. per 1000 cu. ft.	0·65 cc. per cu. ft.
3·0 lb. per 1000 cu. ft.	0·78 cc. per cu. ft.
3·5 lb. per 1000 cu. ft.	0·91 cc. per cu. ft.
4·0 lb. per 1000 cu. ft.	1·04 cc. per cu. ft.

Methods of Application

Where fumigation of large quantities of commodities is required and the dosage of methyl bromide to be applied is one pound or more, it can be measured by weight. This is done by weighing accurately the cylinder of methyl bromide by placing it on a platform scale. The desired amount is then subtracted from the total and the scales are set at that point. The methyl bromide is released, and when the weight bar again balances, the valve is immediately closed for the desired dosage has been admitted. The tubing near the cylinder should be fixed in a spiral coil of 2 or 3 turns to make its influence on the weight of the cylinder almost constant.

Small quantities of methyl bromide can be introduced through a special glass measure, called the applicator. The capacities of applicators may vary from 10 cc. to 5 pounds. The applicator is inserted between the supply cylinder and the chamber. By the use of valves, the desired amount is admitted to the applicator, which is graduated in cubic centimeters and/or ounces. The methyl bromide remains as a liquid in the applicator as it is still under pressure. When the valves on the chamber side are opened the pressure of methyl bromide forces the dosage into the chamber.

Methyl Bromide Containers

Methyl bromide is obtainable in one pound cans or in steel cylinders of varying sizes containing from 5 to 100 lb. of methyl bromide. These cylinders are designed in such a manner as to take advantage of the natural pressure of the liquid. Additional air pressure is also

added to the cylinder, which together with the natural vapour pressure will cause the liquid to rise through the tubing into the chamber or fumigation space. The cylinders are provided with fusable safety plugs which will melt at 155° F. The cans will distort at 150° F and burst at 185° F to 190° F. Therefore, methyl bromide cans or cylinders should never be subjected to high temperatures and should be stored in cool and well-aerated places. Glass sealed ampoules containing 20 cc. of methyl bromide are sold for delousing purposes.

Care should be taken to see that the cylinder valves are operated with the minimum of force and that the outlets are kept clean and undamaged. The fumigant outlet should remain capped and valves should be protected by helmets, when these are provided, except when applying.

Atmospheric Fumigation

The material to be fumigated is first placed in the chamber. The doors and vents are tightly closed and the circulation fan is turned on and then the fumigant is admitted.

It may not be necessary to allow space between packages or containers when they are placed in the chamber as long as some clearance is allowed next to the ceiling. The floor rack will provide space beneath the material.

It is advisable to run the circulation fan for the duration of the treatment and during loading of large quantities of materials. Tender plants and foliage should be protected from direct air currents and the air velocity should also be decreased.

When fumigation is completed, the chamber should be cleared of gas through the exhaust vent, before opening. This will vary from a few minutes to half an hour or more depending on the size of the chamber, capacity of the blower, and the amount and kind of material being treated. A few tests with the halide detector will enable the operator soon to judge this point. The door should be slightly opened when the vent is opened, otherwise no venting will take place. The treated material should be well aerated, either by continued aeration of the chamber or by removing to a well-ventilated place.

Vacuum Fumigation

Material should be loaded into the chamber in a manner convenient to the operator. The circulation fan should be situated so as to direct the circulation either over or under the load. After closing the chamber tightly, a vacuum slightly in excess of that desired should be drawn, because the introduction of the gas will slightly raise the pressure. The circulating fan should be running throughout the treatment. In all vacuum treatments the initial vacuum should be held throughout the treatment period.

After the exposure period, the chamber is cleared of the gas. The pump is started and an air release valve is opened just enough so that the vacuum is maintained at approximately 25 inches. A 20 minute wash in this manner will be sufficient to remove practically

all the gas from most types of materials. Test with a halide detector can indicate whether this period should be shortened for small or non-absorptive materials or increased for larger and absorptive materials.

Fumigation under Gas-proof Sheeting

A 30 feet square sheet will cover adequately a square stack containing 15 to 30 tons of bagged grain and allow for a gassing dome supported by a few upright sacks at the top of the stack. The most serviceable sheets are those made from a light, closely-woven fabric heavily coated on one side and lightly coated on the other with some impervious material.

Such fumigation should be carried out in the open air or in situations where the release of considerable quantities of gas will not be dangerous. Partial uncovering for about an hour should free the stack from toxic concentrations.

Effect of Temperature and Humidity

Methyl bromide can be conveniently used over a wide range of temperatures and is effective at temperatures at which plant materials can be handled. It should not ordinarily be used for the fumigation of plants and plant materials at lower temperatures and the fumigation is best done between 80° F and 85° F. If the temperature rises, methyl bromide becomes more effective. Therefore, in treatments where temperatures are specified, it is essential to be cautious about increases or decreases in the temperature as these will change the dosage rate.

High humidity, both during the conditioning for treatment and during the treatment, tend to minimise plant injury. Humidity should be maintained as high as possible in the fumigation chamber where tender plant material is placed. This can be obtained by placing a wet gunny or basin of water in the chamber or by wetting the walls and floor of the chamber.

Fumigated plants should be given proper airing and protected against direct sunlight and dry winds. Such plants should also be properly watered.

Penetration and Aeration of Packages and Packing Cases

Methyl bromide has a very good penetrating quality and plant materials and seeds wrapped in kraft paper need not be transferred for fumigation or airing. However, most types of cellophane, glazed paper, waxed paper, laminated paper or waterproof paper are not permeable and should be removed or opened. These not only prevent the penetration of methyl bromide into the packages but retain the gas that does penetrate for long periods. Since methyl bromide diffuses downwards an open top permeable sack or wrapping should be placed on its side so that proper airing may take place.

Methyl bromide cannot easily penetrate tightly-packed wooden cases. Lids of such cases should be removed for fumigation and they should be placed on their sides so that proper aeration can take place. Otherwise, the gas will be pocketed inside the case for sometime after fumigation, particularly if absorptive material, such as, peat moss or vermiculite, is present. Corrugated paper cartons are usually quite permeable and no particular precautions need be taken unless they have linings of waterproofed, laminated or glazed paper, which are non-permeable.

Detection of the Gas

Methyl bromide is odourless except at very high concentrations. Therefore, ordinarily it becomes necessary to determine the presence or absence of methyl bromide in the atmosphere, in or around the fumigation chamber so that the workers may not be exposed to the vapours of the gas. A halide detector lamp has been found to be the easiest and the most useful means of determining the presence or absence of harmful concentrations of methyl bromide. Various types of this detector lamp are marketed by refrigeration supply companies as leak detectors. Some of the types are, Prestolite leak detector, Frigidaire leak detector, Just-rite leak detector and the Tilly lamp. The leak detector consists of an acetylene or alcohol torch which heats a copper cone, and the air tube or hose by which the air tube is attached, is passed through the cone.

When the leak detector lamp is placed in air containing methyl bromide, a green or blue flame will be seen, depending upon the concentration of the gas present. If the colour of the flame of the detector lamp is deeper than a light green, it denotes the presence of harmful concentrations of the gas. The flame colour indications associated with different concentrations of methyl bromide are mentioned below :

Parts methyl bromide per million	*Pounds methyl bromide per* 1,000 *cu.ft.*	*Flame colour*
0	0	Almost invisible
40	0·010	Rather faint green
60	0·014	Moderate green
100	0·024	Moderate green
130	0·031	Strong green, slightly blue at edges
180	0·043	Strong blue, rather blue
240	0·058	Strong blue—green
360	0·086	Strong blue—green
800	0·192	Strong blue

The halide detector lamp should be well cared for. In some types the copper cone requires occasional renewal, in which case the lamp should be burned for ten minutes before it is used for a test. The lamp should give a flame free from green colour if burning in air free from halide. If a green colour persists even after burning for some minutes in fresh air, the fuel should be replaced by a fresh supply.

Sometimes the suppliers add warning substances of a pungent or lachrymatory character to methyl bromide as a safeguard against misuse or failure to detect serious leakage. Embafume 'D' brand methyl bromide contains 2% chloropicrin which acts as a lachrymatory indicator.

Dosage Schedule

A dosage schedule is composed of three equally important components, the dose, the exposure period and the temperature level. When one is changed, another must be changed to compensate. If fumigation is desired below 40° F, the rate can be proportionately increased for each 10° drop (either dosage or exposure period). It is also permissible to interpolate schedules for 5° temperature difference. Dosage schedules of methyl bromide in most instances have been worked out for plants, fruits in freight or refrigerator, carriages and under tarpaulins, and grains. Ordinary 1 to 1½ lb. methyl bromide per 1,000 cu. ft. of space is used for fumigation of agricultural seeds and bagged grain under atmospheric pressure with an exposure period of 12 to 24 hours. Under vacuum fumigation, the dosage is increased to 3 to 4 lb. per 1,000 cu. ft. and the exposure period is reduced to 3 to 4 hours. The dosage schedules for plants and plant materials are given at the end of this article.

Hazards of Methyl Bromide

Methyl bromide is hazardous if not properly used. Operators and workers should avoid exposure to the vapours of methyl bromide. Ordinarily the chances of exposure to methyl bromide are during fumigation, exhaustion of the gas and also during handling of the fumigated material. Leakage in the chamber and also in the cylinder, contaminates the atmosphere with methyl bromide vapours. At present 17 to 20 p.p.m. by volume of air is considered as the maximum safe concentration of methyl bromide for prolonged human exposure. Inhalation of air with greater concentration of this gas may seriously damage the central nervous system. Brief but repeated contacts or prolonged contacts of the liquid or vapour with the skin or mucous membrane may cause severe burns. It has been estimated that single exposures, not more than once a week, to 100, 400 and 1,000 p.p.m. of methyl bromide for 7 hours, one hour and 0.1 hour, respectively are safe for human subjects. Repeated exposures to 20 p.p.m. of methyl bromide for 8 hours a day, and five days per week, is also considered safe. It is always safe to have two persons during a fumigation operation. Fumigation must be carried out in such a way that gas masks and other protective equipment serve, as far as possible,

as amergency equipment only, and all precautions should be taken to avoid exposure to methyl bromide. A danger sign should be put in places where fumigation is in operation and where methyl bromide is stored.

Protection of Operator

Methyl bromide is highly poisonous and should be handled with the greatest care. Fumigation with it should be undertaken only by responsible and technically trained operators. The operator should be familiar with the properties of the gas and should be fully conversant with the precautionary measures. Although the closed system in applying methyl bromide, coupled with the venting system, which carries the gas away at the end of the fumigation, reduces the hazards of exposure and assures maximum safety to the operator, great care should be taken in using it. The workers handling the fumigated material should be protected by observing all the precautionary measures. A flow of air from behind the workers should be provided to carry sorbed gas away from them.

Gas masks equipped with a canister designed to protect against the vapours of methyl bromide alone should be used. Gas masks should be tested for leakages before using them. A canister as supplied by the manufacturer is sealed by a cap over the inlet valve at the bottom and a cork in the hose nipple. The cap should be removed during use and replaced thereafter. The canister may, sometimes, deteriorate even without use. It should be replaced, if difficulty in breathing is felt during the testing of a gas mask. Type 'O' black canisters with orange stripe may be used for protection against methyl bromide with 'Puretha' gas respirators. There is no means of telling when a canister is approaching exhaustion. It is safe to use a canister for about two months if it is used regularly and whenever it shows signs of deterioration it should be discarded.

Gas mask should be used only as a precautionary measure and should not be used in heavy concentrations of the gas. Gloves should not be used for handling methyl bromide because of the danger of concentrated vapour being trapped in them. Smoking should not be allowed in atmosphere containing methyl bromide vapours. Contact of liquid methyl bromide with skin or clothing should be avoided. In practice, fumigation should be carried out in such a manner as to require gas masks only as an emergency equipment.

Symptoms of Methyl Bromide Poisoning

The onset of symptoms may be delayed upto 48 hours and the effects vary according to the degree of exposure. The early signs of poisoning resemble those of a hypnotic agent, such as excessive fatigue, headache, dizziness, nausea, vomiting, abnormal hearing and vision, mental confusion, muscular weakness and collapse.

The symptoms should disappear and recovery be complete if the exposure to the fumigant is stopped in time. If the exposure continues, damage to the central nervous system becomes evident through

epileptiform convulsions. Exposure to high concentrations may result in oedema of the lungs. Psychic disturbances, paralysis and amnesia. characterise the recovery phase.

Damage to skin or mucous membrane appears as redness or itching followed by blistering.

First Aid

Any person accidentally exposed should have medical attention immediately. The following steps should be taken at once in the case of a person suspected to be suffering from methyl bromide poisoning :

(1) Remove the patient to fresh air.

(2) Inspect all clothing, including boots, gloves and cap. Remove any that may be contaminated. Thoroughly wash with plain water the parts of the skin which have been contaminated.

(3) Keep the patient warm. A hot drink will do no harm, but do not administer strong alcoholic stimulants without medical advice.

(4) If convulsions occur, the usual precautions should be observed. Care should be taken to see that the patient's breathing is not obstructed and that he does not bite his tongue or otherwise injure himself by involuntary movements.

(5) Send for a doctor, or if there is likely to be any delay, take the patient to the nearest doctor or hospital.

(6) Do not use Adrenaline.

Methyl Bromide Residue

The amount of gas sorbed by foodstuffs is much less for methyl bromide than for most other fumigants. In the first instance, methyl bromide is taken up by foodstuffs by physical absorption, which is a reversible process, because such gas will be desorbed during the airing period. The amount of methyl bromide sorbed by different foodstuffs varies considerably according to the composition and degree of fineness of the material. Adsorption is also high on materials of high protein or high oil content such as groundnut and other oilseeds. Part of the physically adsorbed methyl bromide reacts chemically with the foodstuffs and this reaction continues so long as methyl bromide is present in the material. This process of chemical reaction is irreversible and the methyl bromide which has reacted chemically cannot be recovered or removed during airing. It remains as a fixed residue of water-soluble inorganic bromide. The amounts of bromide remaining in foodstuffs after fumigation are not in themselves considered harmful but serve as a useful guide to the extent of the reaction which has taken place. The reaction of methyl bromide with foodstuffs under fumigation conditions does not appear to reduce their nutritive value.

Under normal conditions of fumigation there is no tainting of fumigated materials. A slight foreign odour arising after fumigation usually disappears quickly during airing and storage.

Extensive work on the residue of methyl bromide on many plants and plant materials has been done in U.S.A. The residue tolerances of methyl bromide, post-harvest fumigation, on different plant materials are given below (Official F.D.A., Tolerances; U.S.D.A.).

Plant material	*Residue, Parts per Million of Inorganic bromide calculated as Bromine*
Apples, pears, quince	5
Brinjal, onions (including green onions)	20
Beet (garden) roots, rutabaga, turnips	30
Alfalfa hay, barley, beans, green, lima, snap, black eyed peas, cocoa (beans), corn grain (excluding pop corn), grain sorghum (milo), oats, peas (black eyed grain), rice, rye, wheat	50
Potatoes, sweet potatoes	75
Almonds (tree nuts), Brazil nuts, bush nuts, butter nuts, cashewnuts, chestnuts, cotton seed, groundnuts, hazelnuts, hickory nuts, pecan, pistachionuts, walnuts	200

Fumigation of Plants and Plant Materials

Methyl bromide is being used extensively in plant quarantine work for the fumigation of plants and plant materials in many parts of the world. In general, living plant materials and all dormant, non-foliated plant materials are very tolerant. Among the dormant, actively growing, evergreen and foliated plants, there is considerable variation in susceptibility to methyl bromide, some being very tolerant and others easily injured. Methyl bromide is very effective at higher temperatures, within certain limits, and the plant tolerances are not affected greatly when the temperatures approach 90° F. During cold weather the temperature of the chamber should be raised for effective fumigation. Plants should be properly loaded in the chamber and double decking of plants should be avoided. Succulent plants and plants with foliage should not be placed directly in the air current and the velocity of the air current should be reduced to prevent whipping and injury to the plant.

Dosage schedules* for various plants and plant materials are given in Tables 1 to 16. The schedules are arranged for different classes or groups of plant materials in the following manner :—

Plant material	*Table*
Non-foliated, dormant, plant materials—bulbs, corms, roots, perennials, deciduous woody shrubs, latex bearing plants, etc.	1

*Compiled from Manual for methyl bromide fumigation, Bureau of Entomology & Plant Quarantine, U.S.D.A., 1950.

Foliated, dormant, plant materials—broad leaved evergreens—azaleas, rhododendrons, camellias, coniferous evergreens, etc.	2
Non-dormant, green-house plants—green-house grown plants infested with armoured scales, mealy bugs, white flies, etc.	3
Orchids—collected, domestic or hybrid; cattleya and dendrobiums, etc.	4
Seeds for propagation, except cotton, vetch and chestnut	5
Cotton seed and cotton samples	6
Some host plants of the citrus white fly—*Aegle marmelos* (Bael fruit), *Ailanthus* spp. (Tree of heaven), *Camellia* spp. (Camellia or tea), *Choisya ternata* (Mexican orange), *Diospyros* spp. (Persimmon), *Feronia limonia* (Wood apple), *Gardenia* spp. (Gardenia or Cape Jasmine), *Ilex* spp. (Holly), *Jasminum* spp. (Jasmine), *Lingustrum* spp. (Privet), *Melia* spp. (Chinaberry), *Murraya* spp. (Chalcas; Murraea) (Jasmin orange), *Prunus caroliniana* (Carolina laurel-cherry), *Sapindus mukorossi* (Chinese soap-berry), *Severinia* spp. (Box orange), *Swinglea glutinosa* (*Chaetospermum*) (Tabog), *Syringa vulgaris* (Common liliac)	7
Nursery fruit plants—almond, apple, apricot, cherry, etc. and their ornamental forms	8
Broom corn	9
Green pod vegetables, green lima beans, string beans, pigeon peas, peas	10
Cipollini bulbs (*Muscari comosum*)	11
Onions—red and white	12
Garlic	13
Apples and pears	14
Chestnuts	15
Vetch seed	16

In cases where methyl bromide is not tolerated by certain plants or where certain pests cannot be killed by methyl bromide, other fumigants, if recommended, should be used. Otherwise, one of the following methods may be employed :—

(*a*) Detailed inspection to ensure insect-free plants,

(*b*) Removal of insects or infested parts,

(*c*) Hot water treatment where plant tolerance is known.

LITERATURE CONSULTED

Brown, W.B., 1955, Fumigation with methyl bromide under gas-proof sheets, *Pest Infestation Research Bull.* No. 1, Dept. of Sci. and Ind. Res., London.

Cotton, R.T., 1956, Pests of stored grain and grain products. Burgess Publishing Company, Mineapolis, Minn., U.S.A.

Latta Randall, Richardson H.H. and Bulger J.W., 1950, Manual for methyl bromide fumigation. *Jl. Methyl bromide*, Bur. of Ent. and Plant Quarantine, U.S.D.A.

National Agricultural Chemicals Association, Washington, Official Food and Drug Administration Tolerances for residues of pesticide chemicals, *National Agric. Chem. Assoc. News and Pesticide Rev.*, 15(4), May, 1957.

Pruthi, H.S., 1950, Fumigation and other methods of disinfestation of plant materials at India's ports. *Tech. Bull. No.* 2, *Dte. of Plant Protection, Quarantine and Storage,* Ministry of Agriculture, Government of India, New Delhi.

Rowe, V.K., 1957, Toxicological hazards and properties of commonly used grain fumigants. *Pest Control,* 25(9).

TABLE 1

Fumigation of non-foliated dormant plant materials with methyl bromide

Plant material	Temp. °F	Atmospheric fumigation	
		Lb. per 1000 cu. ft.	Exposure, in hours
Bulbs, corms etc., roots, crowns, perennials, deciduous woody shrubs, barerooted fruit and shade trees, latex- bearing plants	40	3	3·5
	50	3	3
	60	3	2·5
	70	3	2
	80	2·5	2
	90	2	2

Atmospheric fumigation should be done for all surface type insects. Add ½ hour to all atmospheric schedules for *Brachyrhinus* larvae.

Vacuum fumigation (Vacuum 26 inches) should be done for internal feeding insects, such as, larger bulb fly, borers, gladiolus thrips, etc. at the atmospheric dosage schedule.

TABLE 2

Atmospheric fumigation of foliated dormant plant materials with methyl bromide

Plant material	Temp. °F	Lb. per 1000 cu. ft.	Exposure, in hours	Remarks
Broad leaved evergreens, such as azaleas, rhododendrons, camellias, ilex, etc., coniferous evergreens	40	2·5	3·5	Use schedule in Table 3 for *Araucaria.* Use schedule in Table 1 for *Brachyrhinus* larvae.
	50	2·5	3	
	60	2·5	2·5	
	70	2·5	2	
	80	2	2	
	90	1·5	2	

TABLE 3

Atmospheric fumigation of non-dormant green-house or glass-house grown plant materials with methyl bromide

Plant material	Temp °F	Lb. per 1000 cu. ft.	Exposure, in hours	Remarks
Green or glass-house grown plants infested with armoured scales, mealy bugs, thrips, red spiders, white flies, aphids, leaf miners.	40	3·5	2	Use schedule in Table 1 for Cyclamen mite. Do not fumigate plants with soft scales and borers, and rooted cuttings of chrysanthemums.
	50	3	2	
Only tolerant plants should be fumigated.	60	2·5	2	
	70	2	2	
	80	1·5	2	
	90	1	2	

TABLE 4

Fumigation of collected, domestic or hybrid orchids with methyl bromide

Plant material	Temp. °F	Lb. per 1000 cu. ft.	Exposure, in hours	Remarks
	Atmospheric Fumigation			
A. Non-dormant orchids from glass or green-houses, infested with armoured scales, mealy-bugs, aphids, white flies, etc.	40	3·5	2	Soft scales on dormant orchids and galls caused by Cecidomyid larvae should be removed by hand.
	50	3	2	
	60	2·5	2	
	70	2	2	
	75	1·75	2	
	80	1·5	2	
	90	1	2	
B. Collected orchids	40	3	3·5	
	50	3	3	
	60	3	2·5	
	70	3	2	
	80	2·5	2	
	90	2	2	
	Vacuum Fumigation (vacuum 15 inches)			
Collected orchids of Cattelya group infested with *Mordellistena* sp., Cattleya fly, soft scales or weevil larvae; Dendrobiums infested with borers; Shipping crates with bamboo slats infested with the bamboo shot hole borer, *Dinoderus minutus*.	40	3	3·5	
	50	3	3	
	60	3	2·5	
	70	3	2	
	80	3	1·5	
	90	3	1	

TABLE 5

Fumigation of seed with methyl bromide

Plant material	Temp. °F	Atmospheric fumigation		Vacuum fumigation (vacuum 26 inches)	
		Lb. per 1000 cu. ft.	Exposure, in hours	Lb. per 1000 cu. ft.	Exposure, in hours
All seeds for propagation purposes, except cotton seed, vetch seed in commercial quantities and chestnuts.	40	3	3·5	3	3·5
	50	3	3	3	3
	60	3	2·5	3	2·5
	70	3	2	3	2
	80	2·5	2	3	1·5
	90	2	2	3	1

Vacuum fumigation should be used for nut-like seed where seed samples are tightly packed in the same container or where the nature of packing may retard the penetration of the gas.

TABLE 6

Fumigation of cotton seed and cotton samples with methyl bromide

Plant material	Temp. °F	Atmospheric fumigation		Vacuum fumigation (vacuum 26 inches)	
		Lb. per 1000 cu. ft.	Exposure, in hours	Lb. per 1000 cu. ft.	Exposure, in hours
Cotton seed for experimental purposes and cotton samples.	40 or above	3	24	4	2

The load of the consignment should not ordinarily exceed 50 per cent of chamber capacity.

TABLE 7

Atmospheric fumigation of citrus white fly hosts with methyl bromide

Plant material	Temp. °F	Lb. per 1000 cu. ft.	Exposure, in hours	Remarks
Bael fruit, tree of heaven, camellia, tea, Mexican orange, persimmon, wood apple, gardenia, cape jasmine, holly, jasmine, privet, chinaberry, *Murraya* spp., Carolina laurel—cherry, Chinese soap—berry, box orange, tabog, common liliac.	70	2	3·5	This schedule can be used against other pests on these hosts, if they can be killed by methyl bromide.
	80	2	2·5	
		2·5	2	
	85	1	4	

TABLE 8

Atmospheric fumigation of some fruit plants with methyl bromide

Plant material	Temp. °F	Lb. per 1000 cu. ft.	Exposure, in hours	Remarks
Nursery plants, such as, almond, apple, apricot, cherry, chokecherry, hawthorne, nectarine, peach, pear, plum and quince, including their ornamental forms.	60	3	4	This schedule is used for oriental fruit moth, but it can also be used against other pests, provided they can be killed by methylbromide. Fumigation below 60 F° should not be done.
	70	2	4	

TABLE 9

Fumigation of broom corn with methyl bromide

Plant material	Temp. °F	Atmospheric fumigation		Vacuum fumigation (vacuum 26 inches)	
		Lb. per 1000 cu. ft.	Exposure, in hours	Lb. per 1000 cu. ft.	Exposure, in hours
Broom corn infested with European corn borer larvae, *Sesamia cretica* larvae or other insects including the sugar-cane borers.		10	—	9·5	2·5
		20	—	8	2·5
		30	—	6·5	2·5
		40	4·5	5	2·5
		45	4	—	—
		50	3·5	Overnight, minimum 16 hours 3·5	2·5
		55	3	—	—
		60	2·5	2·5	2·5
		65 and above	2	2·5	2·5

TABLE 10

Fumigation of green pod vegetables with methyl bromide

Plant material	Temp. °F	Atmospheric fumigation		Vacuum fumigation (vacuum 15 inches)	
		Lb. per 1000 cu.ft.	Exposure, in hours	Lb. per 1000 cu. ft.	Exposure, in hours
Green pod vegetables, including green lima beans, string beans, pigeon peas, which may be infested with larvae of *Maruca testutalis*, *Epinotia opposita* and *Laspeyresia leguminis*.	40	3·5	2	3	1·5
	50	3	2	2·5	1·5
	60	2·5	2	2	1·5
	70	2	2	1·5	1·5
	80	1·5	2	1	1·5
	90	1	2	0·5	1·5

TABLE 11

Vacuum fumigation of Cipollini bulbs (Muscari comosum) with methyl bromide (vacuum 15 inches)

Plant material	Temp. °F	Lb. per 1000 cu. ft.	Exposure, in hours
Cipollini bulbs infested with the Chrysomelid, *Exosoma lusitanica* or the narcissus bulb fly, *Merodon equestris*.	40	4	4
	50	4	3
	60	4	2
	70	3	2
	80	2	2

TABLE 12

Atmospheric fumigation of onions with methyl bromide

Plant material	Temp. °F	Lb. per 1000 cu. ft.	Exposure, in hours
Red and white onions	40	3	3·5
	50	3	3
	60	3	2·5
	70	3	2
	80	2·5	2
	90	2	2

TABLE 13

Vacuum fumigation of garlic with methyl bromide (vacuum 15 inches)

Plant material	Temp. °F	Lb. per 1000 cu. ft.	Exposure, in hours
Garlic infested with garlic weevil, *Brachycerus* sp. or the larvae of the carpenter moth, *Dyspessa* sp.	40	3	4
	50	3	3
	60	3	2
	70	2	2
	80	2	1

TABLE 14

Atmospheric fumigation of apples and pears with methyl bromide

Plant material	Temp. °F	Lb. per 1000 cu. ft.	Exposure, in hours
Apples and pears infested with codling moth	32	5	2
	40	4	2
	50	3	2
	60	2·5	2
	70 and above	2	2

TABLE 15

Fumigation of chestnuts with methyl bromide

Plant material	Temp. °F	Atmospheric fumigation		Vacuum fumigation (vacuum 26 inches)	
		Lb. per 1000 cu. ft.	Exposure, in hours	Lb. per 1000 cu. ft.	Exposure, in hours
Edible chestnuts infested with larvae of *Laspeyresia splendana, Curculio* (*Balaninus*) sp., etc. Chestnuts for propagation should be fumigated under vacuum.	40	6	6	4	5
	50	6	5	4	4
	60	5	5	4	3
	70	5	4	4	2
	80	4	4	3	2
	90	4	3	2	2

TABLE 16

Fumigation of vetch seed with methyl bromide

Plant material	Temp. °F	Atmospheric fumigation		Vacuum fumigation (vacuum 26 inches)	
		Lb. per 1000 cu. ft.	Exposure, in hours	Lb. per 1000 cu. ft.	Exposure, in hours
Vetch seed in large quantities. For small quantities or packages use schedule in Table 5.	40	3	7	3	3·5
	50	3	6	3	3
	60	3	5	3	2·5
	70	3	4	3	2
	80	3	3	3	1·5
	90	3	2	3	1

PLANT PROTECTION AGREEMENT FOR THE SOUTH-EAST ASIA AND PACIFIC REGION

The Contracting Governments, desiring to prevent, through concerted action, the introduction into and spread within the South-East Asia and Pacific Region of destructive plant diseases and pests, have concluded the following Agreement, which is a supplementary agreement under Article III of the International Plant Protection Convention of 1951 :

Article I

Definitions

In this Agreement and in the appendices hereto, the following terms shall have the meaning hereby assigned to them, save as otherwise provided :

(*a*) The South-East Asia and Pacific Region, hereinafter called "The Region," comprises the territories in South-East Asia east of the western border of Pakistan and south of the Himalayas, the southern border of China and the northern border of the Philippines, and all those territories in the Pacific Ocean, the South China Sea and the Indian Ocean situated wholly or partly in the area bounded by longitudes 100° East and 165° West and latitudes 15 ° North and 20° South, but excluding Australia;

(*b*) "plant" or "plants" means all species of plants or parts thereof, whether living or dead (including stems, branches, tubers, bulbs, corms, stocks, budwood, cuttings, layers, slips, suckers, roots, leaves, flowers, fruits, seeds and any other parts of plants);

(*c*) "territory" means a State or Territory within the Region defined in (a) above;

(*d*) "the Organization" means the Food and Agriculture Organization of the United Nations;

(*e*) "the Committee" means the Plant Protection Committee for the South-East Asia and Pacific Region established in pursuance of Article II of this Agreement.

The FAO sponsored an International Plant Protection Convention in 1951, to which the Government of India became a signatory in 1952. Under Article III of the Convention, a Plant Protection Agreement for the South-East Asia and Pacific Region was sponsored by the FAO in 1956. The Agreement came into force on 2nd July 1956, having been signed by the Governments of Australia, Ceylon, United Kingdom, Laos, Netherlands, Indonesia, Portugal, Viet-Nam and India.

Article II

Regional Committee

1. The Contracting Governments hereby establish a regional committee, to be known as the Plant Protection Committee for the South-East Asia and Pacific Region, whose functions shall include :

(*a*) the determination of procedures and arrangements necessary for the implementation of this Agreement and the making of recommendations to the Contracting Governments accordingly;

(*b*) the review of reports submitted by the Contracting Governments of progress in the implementation of this Agreement;

(*c*) the consideration of problems requiring cooperation on a regional basis and of measures for mutual assistance.

2. Each Contracting Government shall be represented on the Committee and shall have one vote. A majority of the Contracting Governments shall constitute a quorum. Decisions of the Committee shall be taken by a majority of the votes cast except as otherwise provided in this Agreement.

2. The Committee shall meet whenever convened by the Director-General of the Organization after consultation with the Chairman of the Committee. The Director-General of the Organization shall convene the Committee at least once every two years or when so requested by at least one-third of the Contracting Governments.

4. The Committee shall elect from amongst the delegates a Chairman who shall serve for a period of two years or until the first session of the Committee held after the expiration of the period of two years. The Chairman shall be eligible for re-election.

5. Expenses incurred by delegates of Contracting Governments in attending sessions of the Committee shall be determined and paid by their respective Governments. The Director-General of the Organization shall appoint and provide the secretariat of the Committee from the staff of the Organization who shall serve only during the session of the Committee. The expenses of the secretariat of the Committee shall be determined and paid by the Organization.

6. The Committee shall establish its own rules on procedure.

Article III

Measures Regarding the Importation of Plants from Outside the Region

For the purpose of preventing the introduction into its territory or territories of destructive diseases and pests, and in particular those listed in Appendix A of this Agreement, each Contracting Government shall use its best endeavours to apply, with respect to the importation of any plants, including their packings and containers, and any

packings and containers of plant origin, from anywhere outside the Region, such measures of prohibition, certification, inspection, disinfection, disinfestation, quarantine, destruction or other measures as may be recommended by the Committee, taking into consideration the provisions of Articles V and VI of the International Plant Protection Convention.

Appendix A to this Agreement may be modified by a decision of the Committee.

Article IV

Measures to Exclude South American Leaf Blight of Hevea from the Region

In view of the importance of the Hevea rubber industry in the Region, and of the danger of introducing the destructive South American leaf blight (*Dothidella ulei*) of the Hevea rubber tree, the Contracting Governments shall take the measures specified in Appendix B to this Agreement. Appendix B to this Agreement may be modified by a decision of the Committee taken unanimously.

Article V

Measures Regarding Movement of Plants within the Region

For the purpose of preventing the spread within the Region of destructive diseases and pests, each Contracting Government shall use its best endeavours to apply, with respect to the importation into its territory of any plants, including packings and containers, and any packings and containers of plant origin, from another territory within the Region, such measures of prohibition, certification, inspection, disinfection, disinfestation, quarantine, destruction or other measures as may be recommended by the Committee, in addition to measures already adopted by each Contracting Government.

Article VI

General Exemption

This Agreement shall not apply to the following plants and plant products except in so far as any such plants or plant products are explicitly made subject to specific measures of control provided in this Agreement or recommended by the Committee :

(*a*) any plants imported for food or for analytical, medicinal or manufacturing purposes ;

(*b*) all seeds of annual or biennial field crops or vegetables, and all seeds or cut flowers of annual, biennial or perennial ornamental plants which are essentially herbaceous in character; and

(*c*) any processed plant products,

Article VII

Settlement of Disputes

If there be any dispute regarding the interpretation or implementation of this Agreement, or regarding action taken by any Contracting Government under this Agreement, and such dispute cannot be resolved by the Committee, the Government or Governments concerned may request the Director-General of the Organization to appoint a committee of experts to consider such disputes.

Article VIII

Rights and Obligations of Contracting Governments not Parties to the International Plant Protection Convention

Nothing in the International Plant Protection Convention shall affect the rights and obligations of Contracting Governments which are not parties to the Convention.

Article IX

Amendment

1. Any proposal by a Contracting Government for the amendment of this Agreement, except Appendices A and B shall be communicated, through the Committee, to the Director-General of the Organization.

2. Any proposed amendment of this Agreement received by the Director-General of the Organization shall be presented to a session of the Council of the Organization for approval.

3. Notice of any proposed amendment of this Agreement shall be transmitted to the Contracting Governments by the Director-General of the Organization not later than the time when the agenda of the session of the Council at which the matter is to be considered is despatched.

4. Any such amendment of this Agreement, approved by the Council of the organization, shall come into force with respect to all Contracting Governments as from the thirtieth day after acceptance by two-thirds of the Contracting Governments. Amendments involving new obligations for Contracting Governments, however, shall come into force in respect of each Contracting Government only on acceptance by it and as from the thirtieth day after such acceptance.

5. The instruments of acceptance of amendments shall be deposited with the Director-General of the Organization. The effective date of acceptance shall be the date of such deposit. The Director-General of the Organization shall inform all Contracting Governments of the receipt of acceptances and the entry into force of amendments.

Article X

Signature and Adherence

1. The Government of any State situated in the Region, or any Government which is responsible for the international relations of a territory or territories in the Region, may become a party to this Agreement, by either :

(*a*) signature; or

(*b*) signature subject to ratification followed by such ratification; or

(*c*) adherence.

Governments may not subject their signature, ratification or adherence to any reservation.

2. This Agreement, the text of which was approved by the Council of the Organization on 26 November, 1955, shall be open for signature until 30 June, 1956 or until the date of its entry into force in conformity with the provisions of Article XI, paragraph 1, whichever date is the later. The Director-General of the Organization shall immediately inform all signatory Governments of the signature of this Agreement by any other Government. Ratification shall be effected by the deposit of an instrument of ratification with the Director-General of the Organization and shall become effective as from the date of deposit.

3. This Agreement shall be open for adherence as from 1 July, 1956 or from the date of its entry into force in conformity with the provisions of Article XI, paragraph 1, whichever date is the later. Adherence shall be effected by the deposit of an instrument of adherence with the Director-General of the Organization and shall become effective as from the date of deposit.

4. The Director-General of the Organization shall immediately inform all signatory and adhering Governments of the deposit of an instrument of ratification or of adherence.

Article XI

Entry into Force

1. This Agreement shall come into force as soon as three Governments have become parties to it, either by signature, or by signature subject to ratification followed by such ratification.

2. The Director-General of the Organization shall notify all signatory Governments of the date of entry into force of this Agreement.

Article XII

Denunciation and Termination

1. Any Contracting Government may, at any time after the expiration of one year from the date on which it became a party to the Agreement, or from the date on which the Agreement entered into force, whichever is the later, denounce this Agreement by notification addressed to the Director-General of the Organization who shall at once inform all signatory and adhering Governments of the denunciation.

2. The denunciation shall take effect one year from the date of receipt of the notification by the Director-General of the Organization.

3. This Agreement shall automatically be terminated should the parties to it become fewer than three as the result of denunciations.

APPENDIX A

*Destructive Pests and Diseases not yet established in the South-East Asia and Pacific Region**

	Cacao (*Theobroma cacao*)	*Known Distribution*
Sahlbergella singularis Hagl. ..	Capsid	West Africa, Belgian Congo
Distantiella theobroma Dist. ..	Capsid	West Africa, Belgian Congo
Marasmius perniciosus Stahel ..	Witches' broom	West Indies, South America
Monilia roreri Cif.	Monilia pod rot	South America
Trachysphaera fructigena Tabor and Bunting.	Trachysphaera pod rot	Africa
Virus	Swollen shoot	West Africa
Virus diseases		Trinidad
Helopeltis bergrothi	Capsid (Mosquito bug)	West Africa
	Citrus (*Citrus* spp.)	
Anastrepha spp., es. *A. ludens* (Loew.)	Mexican fruit fly	Central America
Deuterophoma tracheiphila Petri	*Mal Secco*	Mediterranean region
Ceratitis capitata	Mediterranean fruit fly	Europe, Middle East Africa, W. Australia, Hawaii, Central and South America, U.S.A. (Florida).
	Coconut (*Cocos nucifera*)	
Pachymerus nucleorum (F.) ..	(A Bruchid)	New World
Theraptus sp.	(A Coreid)	East Africa, Zanzibar
Aphelencoides cocophilus (Cobb.) Goodey	Red Ring disease	West Indies
	Coffee (*Coffea* spp.)	
Antestia spp.	Pentatomid bug	Africa
Leucoptera caffeella (Guer.) ..	White coffee leaf miner	New World, Africa
Planococcus kenyae (Le Pelley)	A mealy bug	East and West Africa
Omphalia flavida Maubl. and Rangel	American leaf spot	Mexico, U.S.A., West Indies, Central and South America.
Trachysphaera fructigena Tabor and Bunting	Trachysphaera fruit rot	Africa
	Cotton (*Gossypium* spp.)	
Anthonomus grandis Boh. ..	Mexican cotton boll worm	West Indies, Mexico, Central America, Venezuela, U.S.A.

*As modified in the Report of the First Meeting of the Plant Protection Committee for the South-East Asia and Pacific Region, Bangkok, 3—7 December, 1956.

Anthonomus spp.	Boll worms	New World
Phymatotrichum omnivorum (Shear) Duggar	Texas root rot	Mexico, U.S.A.
Virus	Leaf curl	Africa
	Hevea Rubber (*Hevea brasiliensis*)	
Dothidella ulei P. Henn. ..	South American leaf blight	Mexico, Central America, Trinidad, South America.
Pellicularia filamentosa (Pat.) Rogers.	Target leaf spot	Central and South America
	Maize (*Zea mays*)	
Diatraea spp.	Stalk borers	Southern U.S.A., Mexico, West Indies, Central America, South America.
	Oil Palm (*Elaeis guineensis*)	
Pachymerus lacerdae (Chevr.)	(A Bruchid)	Nigeria
Pachymerus nucleorum (F.) ..	(A Bruchid)	New World
Pimelephila ghesquierii Tams.	(A Pyralid)	West Africa
Fusarium oxysporum	Fusarium Wilt	West Africa
	Potato (*Solanum tuberosum*)	
Leptinotarsa decemlineata Say ..	Colorade beetle	New World, Europe
Corynebacterium sepedonicum ..	Bacterial ring rot	New World, Europe
Synchytrium endobioticum ..	Black wart	Africa, Europe, South America.
Heterodera rostochiensis ..	Golden nematode	Europe, South America, U.S.A (Long Island).
	Rice (*Oryza sativa*)	
Diatraea spp.	Stem or stalk borers	Southern U.S.A., Mexico, West Indies, Central America, South America.
Ephelis pallida	Panicle disease]	Sierra Leone
Virus	Rice stripe	Japan
Virus		Cuba
	Sugar Cane (*Saccharum* spp.)	
Diatraea spp., esp. *D. saccharalis* (F.)	Stalk borers	Southern U.S.A., Mexico, West Indies, Central America, South America.

Sweet Potato (*Ipomaea batatas*)

Virus	Internal Cork	U.S.A.
Virus	Mottle	Africa (reported to occur in Ceylon).
Virus	Dwarf	Ryukyu Island
	Tapioca	
Virus	Brown streak	East Africa, South Rhodesia
	Tobacco	
Pseudomonas tabacum	Wildfire	America, Africa, Europe, Japan.
	Tomato	
Virus	Spotted wilt	Africa, Australia, Europe, America.

APPENDIX B

MEASURES TO EXCLUDE SOUTH AMERICAN LEAF BLIGHT OF HEVEA FROM THE REGION

1. In this Appendix—

(*a*) "the American tropics" means those parts of the continent of America, including adjacent islands, which are bounded by the Tropic of Capricorn (latitude 23½° S) and the Tropic of Cancer (latitude 23½° N) and the meridians of longitude 30° W and 120° W, and includes the part of Mexico north of the Tropic of Cancer;

(*b*) "Competent Authority" means the officer or Government Department or other agency, which each Contracting Government recognizes as its authority for the purpose of this Appendix.

2. Each Contracting Government shall prohibit by law the importation into its territory or territories of any plant or plants of the genus *Hevea* from outside the Region, unless—

(*a*) the importation is made for scientific purposes, and

(*b*) written permission has been granted for each consignment of plant or plants by the Competent Authority of the importing territory or territories and the importation is in accordance with such special conditions as may be imposed by the Competent Authority in granting such permission, and

(*c*) the plant or plants have been disinfected and freed of any original soil in the country of origin in a manner acceptable to the Competent Authority of the importing territory and are free from pests and diseases, and each consignment of plant or plants is accompanied or covered by a certificate to the effect that the above requirements have been fulfilled and signed by an appropriate authority in the country of origin; and

(*d*) each consignment is addressed to and is received by the Competent Authority of the importing territory.

3. Each Contracting Government shall prohibit by law the importation into its territory or territories of any plant or plants of the genus *Hevea* capable of further growth or propagation (excluding seed) from the American tropics or from any other country in which South American leaf blight (*Dothidella ulei*) is present, unless, in addition to the requirements of paragraph 2 of this Appendix, at a place approved by the Competent Authority of the importing territory and situated outside the Region and outside the American tropics and any other country in which South American leaf blight (*Dothidella ulei*) is present, such plant or plants have been grown for an adequate period at a plant quarantine station for *Hevea* and each consignment of such plant or plants is accompanied or covered by a certificate to the effect that the above requirements have been fulfilled and signed by the officer-in-charge of such quarantine station.

4. Each Contracting Government shall prohibit by law the importation into its territory or territories of any seed of any plant of the genus *Hevea* from the American tropics or from any other country in which South American leaf blight (*Dothidella ulei*) is present, unless, in addition to the requirements of paragraph 2 of this Appendix, such seed, having been examined and again disinfected at a place approved by the Competent Authority of the importing territory and situated outside the Region and outside the American tropics and any other country in which South American leaf-blight (*Dothidella ulei*) is present, has been repacked with new packing materials in new containers, and unless each consignment of such seed is accompanied or covered by a certificate to the effect that the above requirements have been fulfilled, and signed by the officer-in-charge of these operations.

5. Each Contracting Government shall prohibit by law the importation into its territory or territories of any plant or plants of the genus *Hevea* not capable of futher growth or propagation (such as fresh or dried herbarium specimens); unless in addition to the requirements of sub-paragraphs (*a*), (*b*) and (*d*) of paragraph 2 of this Appendix, the Competent Authority of the importing country is satisfied that such plant or plants are required for a legitimate special purpose and that such plant or plants have been sterilized in the country of origin by a method satisfactory to the said Competent Authority.

6. Each Contracting Government shall prohibit by law the importation into its territory or territories of any plant or plants, other than the genus *Hevea,* capable of further growth or propagation and originating in the American tropics or in any other country in which South American leaf-blight (*Dothidella ulei*) is present, unless written permission has been granted for each consignment of such plant or plants by the Competent Authority of the importing territory or territories and the importation is in accordance with such special conditions as may be imposed by the Competent Authority in granting such permission.

7. The Competent Authority of any territory or territories into which any plant or plants of the genus *Hevea* are imported for further growth or propagation shall ensure that such plant or plants are grown under control for such period as will ensure that such plant or plants are free from all pests and diseases before they are released.

LOW VOLUME SPRAYING OF COTTON CROP

BY

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The development of air-assisted, low volume spraying is a fairly recent one and is making very rapid progress. It was not until 1944 that the first commercial, air-assisted sprayer was produced. Since then several types of low volume ground sprayers have been developed for spraying on various crops, such as apple, hops, potato, banana, coffee, cherry, raspberry, black currant and cotton in various countries.

In India, high volume spraying is very common and equally good results are obtained by it as compared to low volume spraying. But it requires huge quantities of water, the coverage of area per machine is low and, consequently, the cost of treatment high. In low volume spraying, air helps in carrying the pesticide to the plants and, therefore, brings down the requirement of water considerably. Besides, it also helps to a great extent in breaking the spray liquid into finer drops which are deposited discretely on the foliage and do not coalesce and run-off like large drops. This has been observed to give increased deposit of the pesticide per unit area and, therefore, in certain cases better control of the pest.

With a view to demonstrating low volume spraying from ground machines and to see its effect on the control of cotton jassids, trials were carried out in the Punjab during August, 1957. The two power sprayers selected for this purpose were 'Solo' knapsack type and 'Matador-1,000'.

Specifications of the Sprayers

Solo

Engine—1·8 to 2 H.P., 2 stroke, aircooled
Spray tank capacity .. 2-1/4 gallons
Emission rate .. .. 1/4 gallon per minute

Fuel tank capacity .. 1/3 gallon
Fuel consumption .. 1 gallon for 5-6 hours
Weight .. .. .. 37 lbs. when empty

Matador-1000

Engine .. .. .. 2-2·5 H.P., 2 stroke, aircooled

Spray tank capacity .. 2-1/2 gallons

Emission rate .. .. 1/4 gallon per minute

Fuel tank capacity .. 1/3 gallon

Fuel consumption .. 1 gallon for 4—6 hours

Weight .. .. .. 70 lbs. when empty

Insecticides used

A mixture of DDT and BHC emulsifiable concentrates was used, which was reported to give satisfactory control of cotton jassids in high volume spraying. These were applied in different quantities as given below :—

Solo sprayer

(*i*) DDT+BHC emulsifiable concentrates in half and half ratio at the rate of 6 oz. (technical) per acre.

(*ii*) DDT+BHC emulsifiable concentrates in half and half ratio at the rate of 8 oz. (technical) per acre.

Matador-1000

DDT+BHC emulsifiable concentrates in half and half ratio at the rate of 8 oz. (technical) per acre, mixed with molasses at the rate of 1/2 gallon for every 1-1/2 gallons of spray liquid to prevent evaporation of drops during drift.

Site of trial

The trial was carried out in the villages Sanet and Kanganwal of Ludhiana district, Punjab. In all, 5 acres were sprayed with the two sprayers. Two acres were sprayed with Solo sprayer, one acre in each village and 3 acres with Matador-1000 in the village Kanganwal only. The jassid infestation in the areas selected was 3 to 5 per leaf, including nymphs and adults.

Dosage per acre and condition of crop

The rate of application of the spray liquid per acre was different for each sprayer, as mentioned below :—

Solo sprayer.—One acre was sprayed with 7½ gallons of spray liquid, which took about one hour to cover the crop thoroughly. The crop was 4′ to 5′—10″ in height, sown in lines and had luxuriant growth. Another acre was sprayed with 8 gallons of spray liquid and the treatment took less than an hour. The crop was 4′ to 5′ in height and sown in lines.

With Solo power sprayer, the crop was treated by carrying the sprayer in between the rows of cotton plants and by directing the delivery tube on the right and left sides, holding it slightly above waist level, so as to cover two rows on either side of the operator.

Matador-1000.—With this sprayer, the spray liquid was applied at 3 gallons per acre and three acres were sprayed in slightly over 2 hours. The growth and condition of the crop were the same as in the plots sprayed with Solo sprayer.

The manner of treating the crop with Matador-1000 was by taking it alongside every fifth row. The spray drops reached as far as 10 feet, which gave satisfactory coverage of the crop on either side.

Result

From visual observations, complete mortality of the cotton jassids was noticed in all the treatments in the sprayed areas. Besides jassids, satisfactory control of the cotton grey weevil (*Myllocerus maculosus* Desb.) and the red cotton bug (*Dysdercus cingulatus* Fabr.) was also noticeable.

Conclusion

Low volume spraying by one of the blower type of sprayers for the control of cotton jassids is promising. It shows the possibility of reducing the volume of the spray liquid, which is usually applied at the rate of 60—100 gallons per acre at present. It can effect economy in insecticide and diluent with equally good results as compared to high volume spraying. The saving in insecticide would equal what is lost in run-off or dripping of the spray liquid resulting from high volume spraying. The saving in cost of carting water, besides the large coverage of area per machine per day, is an additional advantage in low volume spraying. The economics of treatment with high and low volume spraying have been worked out as shown below. The cost of high volume spraying has been worked out on the basis of spraying a mixture of 0.1% BHC plus DDT suspension in the ratio of half and half at the rate of 100 gallons per acre. This has been reported to give good control of cotton jassids in the Punjab and is being recommended to the farmers.

Particulars	Cost in Rs. for treating 10 acres		
	High volume spraying by conventional power sprayer (2.H.P.) @100 gallons per acre	Low volume spraying by 'Solo' power sprayer @8 gallons per acre	Low volume spraying by Matador-1000 @3 gallons per acre
1. Cost of insecticide DDT+BHC (@1 lb. each of active ingredient per acre).	112·00	—	—
2. Cost of insecticide DDT+BHC(@8 ozs. each of active ingredient per acre).	—	56·00	56·00
3. Cost of Petrol	6·00	3·00	3·00
4. Cost of molasses	—	—	2·50 (for 10 lbs.@ 0·25 per lb.)
5. Labour charges @ Rs. 2·00 per man per day (8 hours)	20·00 (five men for two days)	6·00 (three men for one day)	6·00 (three men for one day)
Total cost ..	138·00	65·00	67·50
Cost per acre ..	13·80	6·50	6·75

It will be seen that the cost of treatment by low volume spraying is about half of that of high volume spraying. The expenditure on spraying cotton crop against jassids is worthwhile, judging from the gain in yield obtained as a result of the treatment. There is a report that on an average the treatment brings an increase in yield of cotton by about 5 maunds per acre. The cost of 5 maunds of cotton calculated @ Rs. 25.00 per maund is Rs. 125.00 as against an expenditure of Rs. 6.50 for the treatment.

Acknowledgements

Thanks are due to Mr. R. J. Courshee, F.A.O. Specialist in Plant Protection Equipment, for his help in the trial reported here and to Dr. Sardar Singh, Entomologist, Punjab, and his staff for providing facilities for the work.

FIELD EXPERIMENTS IN THE CHEMICAL CONTROL OF *ALHAGI CAMELORUM*

BY

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Alhagi camelorum, popularly known as 'camel thorn', is a small spinous shrub common in the plains of the Punjab, the drier parts of Kashmir, Rajasthan, Saurashtra, Uttar Pradesh and Delhi. It occurs generally in sandy areas. In Delhi State, it is one of the most obnoxious weeds and is commonly noticed in wheat, barley, oats and gram fields. The weed is common during the *rabi* (winter) season and it flowers during April and May. Pods develop in fair abundance during May and June. Towards the end of July and during August, after a few showers, the aerial parts of the weed gradually dry up. The weed has a deep root system and perennates by an underground rhizome, which can develop new shoots. It is a very hardy weed and extremely difficult to eradicate. Further, because of its spinous nature, it creates difficulties in harvesting the crops.

In 1952, some preliminary field tests were made by the writer on the effectiveness of Phenoxylene, containing MCPA, against this weed and encouraging results were obtained.

Further tests were made in 1955, using the sodium and ammonium salts and esters of 2, 4-D, at different stages of weed growth in non-arable land or in cultivated fields after the harvest of the crops. The chemicals were applied at the rate of 75—100 gallons per acre. The following results were obtained :

Palormone S (80 per cent Sodium salt of 2, 4-D)

Palormone S, at a concentration of 1 oz. in 2½ gallons of water was sprayed on the weed infesting wheat crop, in the vegetative stage, during the middle of January. After a week there was a marked curling and twisting of the shoots. Gradually (after 3 weeks), the aerial parts of some of the plants were entirely dried up, whereas in others the leaves, spines and the tender branches were affected, but the basal stumps did not dry up.

Fernoxone (80 per cent Sodium salt of 2, 4-D)

Fernoxone, sprayed at the above dosage had almost similar effects and after three weeks, the aerial parts mostly dried up.

Trials repeated with Fernoxone during the middle of March, when the weed was in a more advanced stage of growth, gave almost similar results.

Although the aerial parts of the plants dried up in most cases, the underground rhizomes did not seem to have been inactivated, for fresh sprouts were noticed later in several cases.

Further tests were made in more advanced stages of the weed, towards the end of April, with ammonium salt and ester of 2, 4-D. The results were as follows :

Kathon M 7 (Ammonium salt of 2, 4-D, 4 lbs. acid equivalent per gallon)

This was sprayed at concentrations of 1 oz. in 2½ gallons and 2 ozs. in 2½ gallons of water, after the crops were harvested.

As in the case of Palormone S and Fernoxone, there was curling and twisting of the young shoots after a week. After a fortnight of spraying the aerial parts were mostly dried, more so with the higher concentration and in 3-4 weeks about 85 per cent of the plants dried up.

In a random count of dried up and partially dried up plants, taken 26 days after the spray, 259 out of a total of 308 plants, *i.e.*, 84.1 per cent, were completely dried up and the rest were partially dried.

Kathon E-40 (Isopropyl ester of 2, 4-D, 4 lbs. acid equivalent per gallon)

Similar tests were made with Kathon E-40, 1 : 200 and 1 : 400, on three different occasions between April 27 and June 29 in fairly advanced vegetative stages of the weed. After a week of spraying the plants, there was yellowing and gradual drying up of the leaves and thorns, which was more marked when the higher concentration was used. After a fortnight, the aerial parts of 89—100 per cent of the plants were dried up and in three to four weeks usually all plants dried up except on one occasion when only 89 per cent of the plants were found to have dried up.

It may be observed that though the aerial parts of the weed dried up after the treatments fresh sprouts appeared subsequently. Data on the extent of their further development could not be collected. This aspect needs further investigation. Even if the weedicides do not inactivate the rhizomes to an appreciable extent, it may be beneficial to spray the weeds with a light concentration of one of these weedicides to reduce their activity and retard their growth. The treatment can be repeated after a few months to kill any fresh sprouts. The cost of the chemicals, sprayed at the rate of 100 gallons per acre, works out to approximately Rs. 8.12 for Fernoxone (about the same for Palormone S), Rs. 7.50 for Kathon M 7 and Rs. 9.25 for Kathon E-40 for each treatment.

Although the sodium salts are fairly effective, the ammonium salt and the ester are relatively more so. However, the minimum effective dose for each chemical has to be worked out.

Acknowledgements

The writer gratefully acknowledges his indebtedness to Dr. P. R. Mehta, Deputy Director (Plant Diseases), Directorate of Plant Protection, Quarantine and Storage, New Delhi, for invaluable encouragement and to Shri R. Ardhanari, Technical Assistant, for his assistance in this work.

SHORT NOTE

A new Food Plant of the Mango Mealy Bug

Information so far available on the mango mealy bug, *Drosicha mangiferae* Green, and its host plants does not show that tomato (*Lycopersicum esculentum*) has ever been recorded as its host in India. The author had observed it on tomato plants in January, 1953, and later confirmed the observation in January 1954, in Delhi.

The nymphs of *D. mangiferae* emerged towards the middle of January and were found crawling out near the compound wall of a bungalow, in the neighbourhood of which the fertilised females were observed to seek shelter for oviposition in the previous years. These active, little nymphs crawled about on the compound wall and on the ground with a speed to 30″ to 35″ per 5 minutes in search of host plants and finally climbed up and settled on some host plants, *e.g.*, papaya, *Lantana* sp., and also tomato, which were at a distance of 5 to 6 yards from the area where the maximum concentration of these newly emerged nymphs was seen.

The emergence of the nymphs from the soil roundabout the mango trees in the same compound was negligible, compared to the intensity of their emergence in the vicinity of the compound wall which was nearly 20 yards away from some mango trees.

Those nymphs, which went up the tomato plants attached themselves to the main stems and branches of the plants. They were very rarely seen on the midribs of the leaves, the laminae of which were entirely free from them. Sometimes the nymphs crowded themselves so closely on the stems that 16 to 22 nymphs were seen within an inch length of the stem. They fed on tomato plants during their first and second instar periods and then migrated to other host plants.

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NEWS AND NOTES

(i) *Tainting of Onions by Insecticidal sprays*

Investigations carried out during 1955-56 at the Agricultural College, Baptala, showed that BHC imparted a musty odour to onions, though there was an interval of 43 days between the spray treatment and the harvest. Lindane and pestox affected the taste of onions very slightly, which may not affect their market value. These three insecticides were sprayed at a concentration of 0.05% on onion crop raised out of seedlings in a loamy soil. Two rounds of treatments were given, one on 1-2-1956 and the second on 17-2-1956. The harvested produce was air-dried for a week before being subjected to organoleptic tests.

[Extracted from the *Andhra Agricultural Journal*, 4(4), 1957, 100.-104].

(ii) *Control of Slugs Injurious to Orchids*

Garden slugs frequently occur in orchid houses in Hawaii. It is known from various, previous reports that metaldehyde when used as a bait with corn meal or bran attracted slugs and killed them under certain conditions. However, studies carried out at the Hawaii Agricultural Experiment Station have shown that local slugs are not attracted to metaldehyde and that better results are obtained when it is used as a spray than when incorporated in a bait. It appears more likely that the chemical is more effective as a contact than as a stomach poison. Field tests have shown that effective control of slugs can be achieved by spraying slug-infested ground with 1% metaldehyde-water suspension and respraying the area 3 weeks later. This spray material, as well as the application of pinches of 3% metaldehyde powder, has been found effective in killing slugs in orchid pots.

Metaldehyde is not recommended to be sprayed directly on plants, though there are some indications that it is not very toxic to plants.

[Extracted from *Hawaii Farm Science*, 6(2), 1957, 11.]

(iii) *Virus Detection*

A test that detects plant viruses in only 45 minutes instead of three to seven days as required hitherto has been developed at Pennsylvania State University. The new method for early detection may have great economic importance in view of millions of dollars of damage caused by virus diseases of tomatoes, potatoes, sugar beets and other crops. In the procedure, a 2 per cent suspension of red blood cells is added to juice extracts from either the leaf or fruit tissue of a plant.

Clumping of the red blood cells indicates virus infection, and the test has such great sensitivity that it has shown up virus invasion as much as one month before a seemingly healthy tomato plant showed any overt signs of definite infection.

[Extracted from *Agriculture*, London, 64(6), 1957, 311-312.]

(iv) *Worthwhile Spraying of Cereals*

German experience with the hormone weed-killers MCPA and 2, 4-D, used for controlling weeds in corn crops, shows that increases in yields were progressively less as the date of spraying advanced. Thus, spraying at the 4-5 leaf stage increased yields by 15 per cent. Delaying the operation until the 8—15 leaf stage, produced an increase of only 7 per cent in yield. When the crop was fully tillered, spraying only increased yield by 4 per cent.

Where weed infestation was less than 25 per cent, spraying raised yields only by 4 per cent, but an 18 per cent gain was observed when weed infestation was over 50 per cent. With weeds present on this scale, 26 per cent higher yields were obtained from crops sprayed 6 weeks after sowing; 17 per cent higher when spraying took place after 7 weeks; and 9 per cent after 8 weeks. After this time, spraying was of little use.

The figures refer to the results of 10 years' work involving nearly 1,000 experiments.

[Extracted from *Agriculture*, London, 64(7), 1957, 364.]

GOVERNMENT OF PUNJAB

Development Department

No. 238-Agr.-55/536 *Dated 8th March,* 1955

Notification

In exercise of the powers conferred by Section 5 of the Destructive Insects and Pests Act, 1914 (II of 1914), the Government of Punjab is pleased to make the following rules for the detention, inspection, disinfection and destruction of fruits in respect of which a notification has been issued under Section 3 of the said Act, by the Government of India :—

1. (i) All fruits the import of which by air through Amritsar is permitted under the notification of the Government of India in the late Department of Education, Health and Lands No. 320/35-A, dated the 20th July, 1936, as subsequently amended, under Section 3 of the said Act, shall be subject to inspection at Amritsar by the Plant Protection Adviser to the Government of India or by any officer, duly empowered by him in this behalf and shall be fumigated.

   (ii) If on such inspection any fruits are found to be infected by any insect or fungus or other pest, they shall be destroyed by the said officer.

2. If any fruit the import of which by air through Amritsar is prohibited under the notification referred to in rule 1 is imported, it shall be landed at such place as may be appointed in this behalf by the Plant Protection Adviser to the Government of India or by any officer duly empowered by him in this behalf, and destroyed within twenty-four hours of its landing.

3. Any breach of these rules shall be punishable with fine which may extend to one hundred rupees.

L45MofF.A.—S1—400—24-3-60—GIPF.